

At The Ohio State University Neurological Institute, we don't just study neurological problems, we strive to solve them.



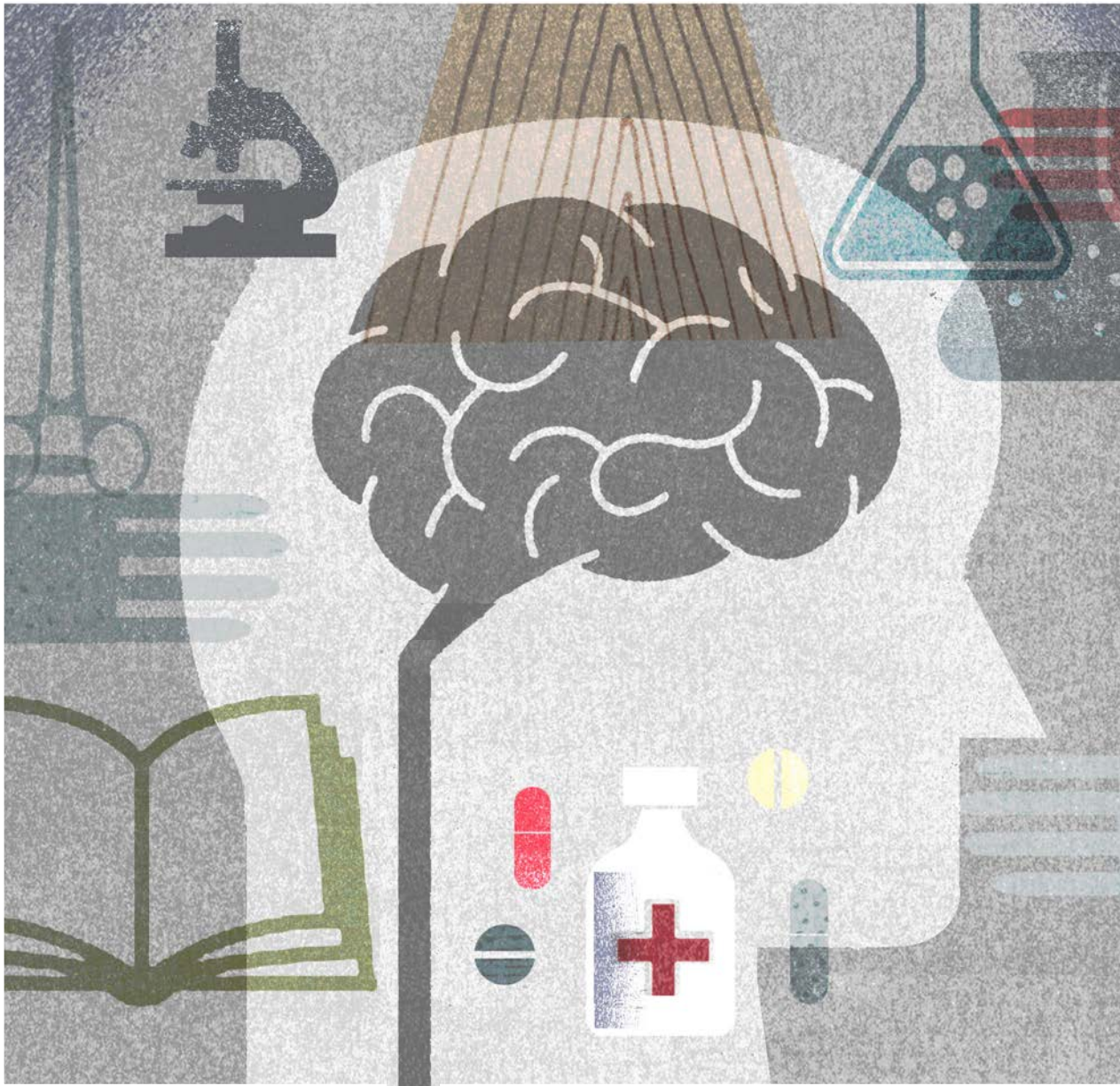
THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER



THE OHIO STATE UNIVERSITY Neurological Institute



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Why a Neurological Institute?



When we conceived the Neurological Institute at the Ohio State Wexner Medical Center in the fall of 2012, we began with an ambitious goal and a common purpose—to provide transformative care and impactful research that would improve the lives of those dealing with neurological disorders. To accomplish this goal, we knew we needed to build a unified multidisciplinary team with a wealth of expertise and diverse perspectives.

Now our team has grown to more than 200 medical practitioners, researchers and technology experts across the University, as well as external partners in academia, industry and government. More than ever, optimum neurological care requires an integrated approach from the bench to the bedside to home—where coordinated, collaborative teams are innovating and spearheading technological advancement to benefit our patients in ways we could never have envisioned.

We are pleased to debut our new state-of-the-art Brain and Spine Hospital—with dedicated specialty units that compliment our psychiatric and rehabilitation hospitals—with 275 beds committed to the treatment of patients with neurological disorders. Our latest initiative is the new Ross Brain Health and Performance Center, applying advances in neuroscience, wearable sensors and biomarkers to improve population brain health and optimal brain performance for all ages.

Whether pioneering brain health and performance, providing a personalized approach to spine care, or enabling a quadriplegic to regain function, our team is advancing the future of neurological care. And our ideas and collaborations only continue to evolve and grow.

We are excited to share the achievements of our dynamic team with you.

Sincerely,
Ali Rezai, MD
Director, Ohio State Neurological Institute
Associate Dean, Neuroscience
Stanley D. and Joan H. Ross Chair in Neuromodulation

Neurological Institute in the News



In the last year **more than 10 billion people** have seen a Neurological Institute expert in the news.

Top news outlets, including *The Wall Street Journal*, *The New York Times*, *The Washington Post*, BBC America, CNN and ABC News, have featured **our experts**.



Device Allows Paralyzed Man To Perform Complex Movements

A study published in *Nature* detailed a partnership between Ohio State and Battelle that allows a paralyzed man to grasp and swipe a credit card or play a guitar video game with his own fingers and hand. These complex functional movements are driven by his own thoughts and a prototype medical system developed by the team.

This work was recognized as a top innovation in medical technologies by *The Wall Street Journal's* Business and Tech section and was honored with a *Popular Mechanics* Breakthrough Award, named among the top stories of 2016 by *Discover* magazine and *Dr. Oz's The Good Life* magazine.

Top Stories



Ohio State's Wexner Medical Center Studying Focused Ultrasound to Treat Essential Tremor

We were one of six locations nationally studying the safety and effectiveness of a promising new technology using MR-guided focused ultrasound to treat patients suffering from essential tremor as part of a multicenter FDA trial.

A Tough Day Could Erase the Perks of Choosing "Good" Fat Sources, Study Finds

A new study suggests that the benefits of good fats vanish when stress enters the picture, according to Ohio State's Institute for Behavioral Medicine Research.



Shakespeare Takes Center Stage Helping Children with Autism Improve Social Skills

A study showed improvement in the social and communication skills of children with autism spectrum disorder using a signature approach pairing the recitation of Shakespeare's rhythmic language with physical gesture.

Study Shows Spinal Cord Injury Causes 'Immune System Paralysis'

New research led by The Ohio State University Wexner Medical Center is showing that spinal cord injuries can also cause a "paralysis" of the immune system that renders these patients more susceptible to pneumonia and other infections.



What is the Ohio State Neurological Institute? 2016 *by the numbers*

WE ARE **5**
HOSPITALS

280,000+
ANNUAL
PATIENT
VISITS

4,500+
SURGERIES

290+
ACTIVE
CLINICAL
RESEARCH
STUDIES

DEPARTMENTS

Neuroscience
Neurology
Neurosurgery

Physical Medicine
and Rehabilitation

Psychiatry and
Behavioral Health

200+
PHYSICIANS AND
RESEARCHERS

5,500+
PATIENTS
ENROLLED IN
CLINICAL
TRIALS

400+
PUBLICATIONS



Ranked number 30 in Neurology/Neurosurgery according to *U.S. News & World Report's* Best Hospitals rankings, jumping more than 20 spots in four years.

Working with 14 schools and colleges across The Ohio State University campus, including the colleges of Engineering and Veterinary Medicine, and with the Department of Athletics to expand understanding of brain and spine disorders and discover diagnostic and treatment tools.



Partnering with leaders in research across campus, including nearly 250 neuroscience researchers at Ohio State, across institutes like the Air Force Research Laboratory at Wright-Patterson Air Force Base and Battelle, and around the world such as the Swiss Federal Institute of Technology in Lausanne, Switzerland, to discover new therapies for brain health and recovery.



Expanding Patient Care and Treatment

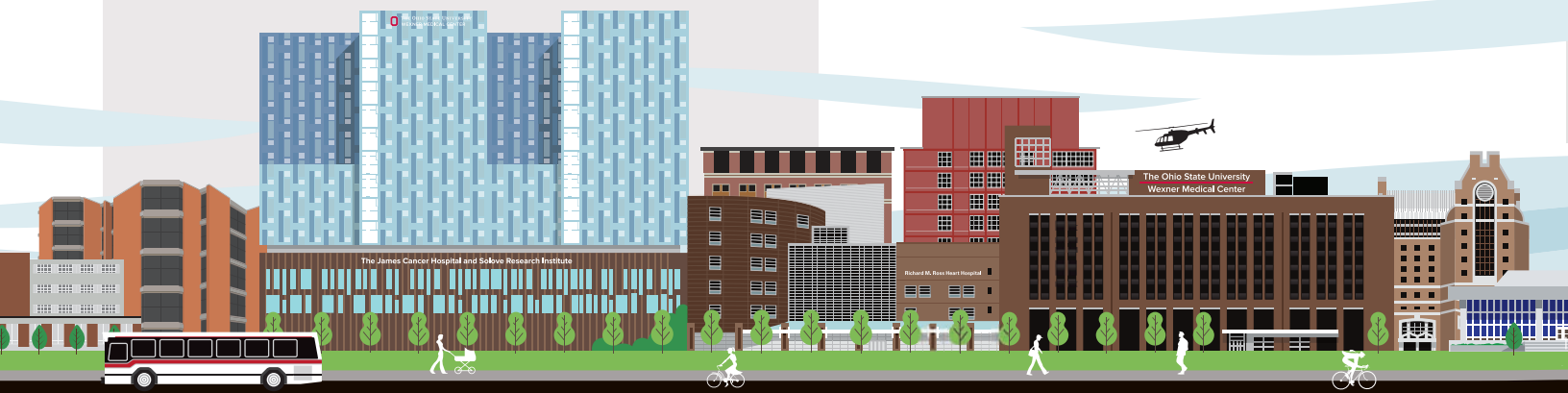
Beds	Hospitals
87	Brain and Spine Hospital
18	Neuro Critical Care Unit
73	Ohio State Harding Hospital
60	Dodd Rehabilitation Hospital
25	Talbot Addiction Medicine
12	James Cancer Hospital and Solove Research Institute Neuro-Oncology Unit

5 Hospitals

12 Outpatient Facilities

280,000+
Square Feet of Inpatient Space

104,000+
Square Feet of Outpatient Space



Neurological Institute Opens Brain and Spine Hospital in September

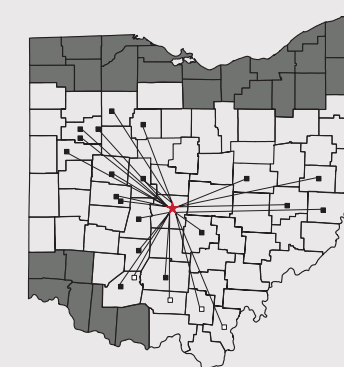
By combining the talent and resources of doctors and researchers at the Neurological Institute in one comprehensive facility, the Ohio State Brain and Spine Hospital elevates the quality of neurological care for our entire community and far beyond. The 87-bed hospital includes specialized units for:

- Stroke care
- Neurotrauma and traumatic brain injuries
- Spinal cord injuries and spine surgery
- Epilepsy
- Clinical trials research
- Chronic pain
- Neuromodulation
- Acute rehabilitation
- Sleep



Telestroke Improves Outcomes and Quality

Headquartered at the Brain and Spine Hospital, Ohio State's Telestroke network provides around-the-clock critical and ongoing support to physicians and patients at 25 "spoke" hospitals that serve rural areas of Ohio. This relationship helps patients get excellent stroke care in their communities and can improve efficiency by preventing unnecessary transfers to larger facilities.





Department of Neuroscience

Chair: Randy Nelson, PhD

Our inaugural “Explorations in Neuroscience” summer camp for high school juniors and seniors launched in summer 2016.

Some Recent Publications from Our Team

Ferraiuolo L, Meyer K, Sherwood TW, Vick J, Likhite S, Frakes A, Miranda CJ, Braun L, Heath PR, Pineda R, **Beattie CE**, Shaw PJ, **Askwith CC**, **McTigue D**, **Kaspar BK**. Oligodendrocytes contribute to motor neuron death in ALS via SOD1-dependent mechanism. *Proc Natl Acad Sci USA*. 2016 Oct. 18;113(42):E6496-E6505.

Hinzey A, Gaudier-Diaz MM, Lustberg MB, **DeVries AC**. Breast cancer and social environment: getting by with a little help from our friends. *Breast Cancer Res*. 2016 May 26;18(1):54.

Todd L, Squires N, Suarez L, **Fischer AJ**. Jak/Stat signaling regulates the proliferation and neurogenic potential of Müller glia-derived progenitor cells in the avian retina. *Sci Rep*. 2016 Oct 19;6:35703.

DiSabato DJ, **Quan N**, **Godbout JP**. Neuroinflammation: the devil is in the details. *J Neurochem*. 2016 Oct;139 Suppl 2:136-153.

Cooper SR, Emond MR, Duy PQ, Liebau BG, Wolman MA, **Jontes JD**. Protocadherins control the modular assembly of neuronal columns in the zebrafish optic tectum. *J Cell Biol*. 2015 Nov 23;211(4):807-814.

Gaudet AD, Fonken LK, Gushchina LV, Aubrecht TG, Maurya SK, Periasamy M, **Nelson RJ**, **Popovich PG**. miR-155 deletion in female mice prevents diet-induced obesity. *Sci Rep*. 2016 Mar 8;6:22862.

Gaudet AD, Mandrekar-Colucci S, Hall JC, Sweet DR, Schmitt PJ, Xu X, Guan Z, Mo X, Guerau-de-Arellano M, **Popovich PG**. miR-155 deletion in mice overcomes neuron-intrinsic and neuron-extrinsic barriers to spinal cord repair. *J Neurosci*. 2016 Aug 10;36(32):8516-8532.

Kigerl KA, Hall JC, Wang L, Mo X, Yu Z, **Popovich PG**. Gut dysbiosis impairs recovery after spinal cord injury. *J Exp Med*. 2016 Nov 14;213(12):2603-2620.



Randy Nelson, PhD

New research includes investigating the role of oligodendrocytes in motor neuron death, cognitive and affective responses to chemotherapy, studying preclinical models of traumatic brain and spinal injuries, examining novel roles of stress in pain and important new research in the use of stem cells in restoring vision.

The Ohio State Department of Neuroscience remains a top-ranked center for fundamental, translational and clinical neuroscience research and education, with more than 25 state-of-the-art research facilities

and services. Twenty-three new grants were awarded to our department over the past year. Supported research covers a range of topics from chemotherapy-induced cognitive deficits, ALS and survival of motor neuron function to alcohol abuse after traumatic brain injury and the effects of circadian rhythm disruption on cancer.

Ohio State’s university-wide Discovery Themes initiative addresses areas of global concern that include promoting the health of people everywhere. These long-term challenges are inspiring our efforts in education, research and social engagement. With a breadth of immense talent that few institutions have, Ohio State researchers in multiple fields are changing how we understand and approach brain injuries. The Neurological Institute is closely aligned to the Chronic Brain Injury Discovery Theme — our two new Discovery Theme faculty hires in chronic brain injuries, Andrea Tedeschi, PhD, and Niki Kokiko-Cochran, PhD, are using cutting-edge techniques to study preclinical models of traumatic brain and spinal cord injuries, as well as Alzheimer’s disease.

With the hope of engaging even more new talent, we launched our inaugural “Explorations in Neuroscience” summer camp this year. High school juniors and seniors interested in brain and spine health interacted with researchers, met with clinicians and watched a live neurosurgery. Focus was also given to the Neuroscience undergraduate major, potential career pathways and options for graduate and medical school.





Department of Psychiatry and Behavioral Health

Chair: John Campo, MD

Our innovative Crisis Assessment, Linkage and Management (CALM) program implements trauma-informed care on inpatient units, enhancing patient safety and reducing incidents of agitation and aggression.



John Campo, MD

Active research projects by Ohio State Psychiatry and Behavioral Health faculty touch on a variety of conditions and treatments, including psychoneuroimmunology, pediatric mood disorders such as depression and bipolar disorder, mental health service delivery and neurofeedback.

The Ohio State Department of Psychiatry and Behavioral Health continues to advance in quality, scope and reputation. Our advances in patient care include our innovative Crisis Assessment, Linkage and Management program, in which implementing trauma-informed care on inpatient units and other quality improvement efforts have enhanced patient safety and reduced incidents of agitation and aggression. The department has also successfully integrated behavioral health services within general medical settings of primary care, cardiovascular medicine, oncology, neurology, sports medicine and transplant. Most recently, the department has become a member of the National Network of Depression Centers and will be collaborating with its 21 members to advance the care of those suffering with mental health and substance use disorders.

Ohio State's Harding Hospital houses a separate psychiatric unit and provides special services for a range of conditions, including serious mental illness, emotional disturbances, Alzheimer's and dementia, disorders of cognition, substance abuse disorders, post-traumatic stress and gender-related mental health issues.

 **More than 6,600**
inpatient admissions

*Treats more than **74,000** outpatients*



Department of Neurology

Chair: John Kissel, MD

Ohio State is one of only seven medical centers in the nation participating in all three of these NIH NINDS initiatives: **NeuroNEXT**, **NETT** and **StrokeNet**.



John Kissel, MD

Ohio State's Department of Neurology is one of the most comprehensive experienced in the nation. We're one of only seven medical centers the nation participating in all three National Institutes of Health (NIH) National Institute of Neurological Disorders and Stroke (NINDS) initiatives:

The Network for Excellence in Neuroscience Clinical Trials (NeuroNEXT) explores promising new therapies for neurological disorders. Baseline results for the very first NeuroNEXT trial, led by Dr. Stephen Kolb from Ohio State, were recently published. The study investigated the natural history and promising biomarkers for babies with type 1 spinal muscular atrophy (SMA), the leading genetic cause of infant death.

The Neurological Emergencies Treatment Trials (NETT) Network focuses on clinical trials to advance treatment of acute neurological disorders. Ohio State was named the nation's highest performing NETT center by the network's executive committee.

NIH StrokeNet addresses all aspects of stroke treatment, including prevention, acute intervention and recovery.

Ohio State is impacting the field of neurology in other ways as well, including participation in and research leadership for several national and international initiatives including:

- **AnswerALS**, a consortium of six centers nationwide focused on unraveling the mysteries of ALS
- **Breakthrough Therapy Designation from the FDA for AVXS-101**, a gene therapy clinical trial being done in collaboration with Nationwide Children's Hospital for treatment of infants with SMA type 1
- **Hematopoietic stem cell transplantation for multiple sclerosis**, an international study led by investigators at Ohio State
- Designation of Ohio State's **Huntington's Disease Clinic** as a Center of Excellence by the Huntington's Disease Society of America, one of only 21 centers in the country to achieve this distinction





Department of Neurological Surgery

Chair: Russell Lonser, MD



Russell Lonser, MD

Our neurosurgical research and associated funding have grown significantly in the last three years. The Ohio State Department of Neurological Surgery was ranked among the top 20 programs in National Institutes of Health (NIH) funding for fiscal year 2015 according to the Blue Ridge Institute for Medical Research. Moreover, the department was ranked eighth in the country with regard to cumulative NIH funding and seventh in the country for academic productivity.

The Ohio State Department of Neurological Surgery is committed to growing all aspects of the tripartite mission of every successful academic department — clinical excellence, research and training of world-class surgeon-scientists. The department's reputation continues to grow substantially, not only within central Ohio, but also across the state, nation and world. This is underscored by the increase in local, national and international referrals, which has driven the rapid expansion of case volume — an increase of nearly 30 percent since 2013.

Successful advancement of these objectives is evident in these recent accomplishments:

- Neurosurgery currently has over 65 active clinical trials and more than 1,200 clinical trial subjects
- Through our basic, translational and clinical science efforts, the Ohio State faculty members are moving neurosurgical science forward in critical and indelible ways

Training is also a significant part of our department vitality and national recognition. Based on our clinical excellence, volume expansion and faculty academic achievements, Ohio State was recently granted expansion of our residency complement. Our neurosurgery residents have demonstrated their excellence in both patient care and academic pursuits, disseminating their neurosurgical knowledge in both publications and national presentations. Subspecialty training options include fellowships in endovascular neurosurgery, minimally invasive cranial surgery, stereotactic and functional neurosurgery, oncological and complex spinal surgery, comprehensive spine center spinal surgery and neuro-oncology.

Neurosurgery currently has over 65 active clinical trials and more than 1,200 clinical trial subjects



Department of Physical Medicine and Rehabilitation

Chair: Jerry Mysiw, MD

Our new SCI Model Systems project focuses on immune deficiency after spinal cord injury. Our dedication to pursue innovations in patient care also extends to the department's clinical programs. Ohio State's cancer rehabilitation program — the second accredited program in the country — continues to grow in both scope and number of faculty. In addition, the expansion of our musculoskeletal programs is evidenced by the recent recruitment of dedicated sports medicine faculty and the integration of that faculty into the vast Jameson Crane Sports Medicine Institute at The Ohio State University.



Jerry Mysiw, MD

Ohio State is one of only seven institutions in the country to be awarded both Traumatic Brain Injury and Spinal Cord Injury Model System grants from the National Institute on Disability, Independent Living, and Rehabilitation Research. The Ohio Regional TBI Model System gathers long-term outcomes information on patients who are part of the system's national database.

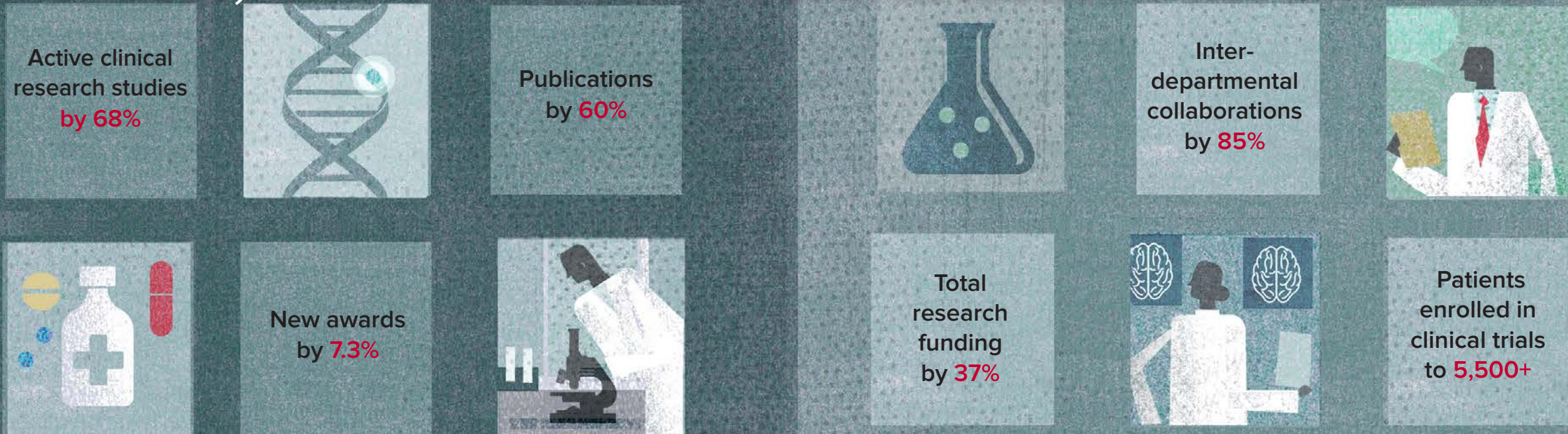
It is estimated that over 53 million adults in America are living with a disability. Recognizing that these numbers will increase even more as our population ages, the Ohio State Department of Physical Medicine and Rehabilitation (PM&R) is strategically prioritizing innovation and discoveries focused on improving the lives of disabled patients. Examples of recent significant developments achieved by our faculty and their collaborators include:

- Developing the first successful brain machine interface system in collaboration with Battelle that allowed a C5 quadriplegic male to regain functionally meaningful movement in his arm. This was accomplished with a neural bridge that interpreted motor cortex activity, bypassed the injured spinal cord and delivered that information to the paralyzed limb
- Pioneering new gaming technology that provides evidence-based rehabilitation intervention to patients with acquired brain injuries. This innovative therapy promotes more patient engagement and enhances both the extent and rate of motor and balance recovery

The new Ohio State Brain and Spine Hospital includes a dedicated spinal cord injury (SCI) unit, placing us at the forefront of SCI care. This unit is uniquely structured and designed to diminish the modifiable risk factors that adversely affect the extent of neurologic recovery and life expectancy after SCI. Neuroscientists and clinical investigators are collaborating with the clinical care teams; associated research is currently focused on developing body sensors that can identify risk for infection and skin breakdown. A second collaboration, associated with our Neural Recovery Program, develops new rehabilitation interventions to improve functional gait after spinal cord injury.



Since 2012, the Neuroscience Research Institute has increased:



Neuroscience Research Institute *a collaborative hub for more than 250 neuroscientists*



Ohio State's Neuroscience Research Institute (NRI) serves as the research and educational arm of the Neurological Institute (NI).

The NRI provides infrastructure support for our research teams guidelines (biostatistics, study design, regulatory, compliance, sponsor opportunities, flexible support-staff models, and training in human subjects protection, Good Clinical Practice and standard operating procedures), supports various educational programs, awards seed money for pilot studies and is developing a central research registry to enhance the ability to provide research opportunities to all patients.

*Pictured at left: Randy Nelson, PhD, Co-Director, Neuroscience Research Institute Chair, Department of Neuroscience
Dr. John D. and Olive E. Brumbaugh Chair in Brain Research and Teaching*



More than 5,500 individuals are actively enrolled in clinical research projects across all departments and centers within the Neurological Institute. This includes more than 300 clinical research studies of which there are approximately 150 clinical trials seeking new interventions to treat a broad range of diseases and conditions.

Ohio State's university-wide Discovery Themes initiative promotes the health of people everywhere. The NRI is closely aligned to the Chronic Brain Injury Discovery Theme where Andrea Tedeschi, PhD, and Niki Kokiko-Cochran, PhD from the Department of Neuroscience are using advanced techniques to study preclinical models of traumatic brain and spinal cord injuries, as well as Alzheimer's disease.

Pictured at left: Douglas Scharre, MD, Co-Director, Neuroscience Research Institute Professor of Clinical Neurology and Psychiatry



CENTER OF NEUROMODULATION

At the Forefront of Scientific and Clinical Discovery and Innovation



“Our multidisciplinary team, comprised of specialists in fields that include neurosurgery, movement disorder neurology, psychiatry, pain management and physical medicine and rehabilitation, sees more than 4,000 patients annually.”

Reversa Joseph, MD
Movement Disorders Neurologist



The Ohio State Center for Neuromodulation performs over 500 neuromodulation procedures per year for conditions such as Parkinson’s disease, essential tremor and traumatic brain injuries. Treatments include neural bypass, deep brain stimulation (DBS) and high-intensity focused ultrasound.

High-Intensity Focused Ultrasound

High-intensity focused ultrasound (HIFU) is an innovative, noninvasive approach that combines more than 1,000 ultrasound probes with neuroimaging to create precise lesions in the brain. Our team was part of a national multi center trial for HIFU thalamotomy in refractory essential tremor that led to FDA approval in July 2016. Patients undergoing ultrasound sonication treatment are evaluated in real time for clinical tremor reduction and side effect in conjunction with MRI imaging and thermography.

“This procedure provides a new noninvasive option for treatment for many patients,” says neurosurgeon



Vibhor Krishna, MD

Vibhor Krishna, MD, who leads the HIFU team (which integrates the skills of neurologists, neurosurgeons, psychiatrists and imagers) with neurologist Punit Agrawal, DO, neurosurgeon Ali Rezai, MD, and neuroradiologist Eric Bourekas, MD.

References: Bouton CE, Shaikhouni A, Annetta V, Bockbrader MA, Friedenber DA, Nielson DM, Sharma G, Sederberg PB, Glenn BC, Mysiw WJ, Morgan AG, Deogaonkar M, Rezai AR: “Restoring cortical control of functional movement in a human with quadriplegia” Nature April 2016.

Rezai AR, Sederberg PB, Nielson DM, Zhang J, Mysiw WJ, Knopp MV, Corrigan JD: Improved function after deep brain stimulation for chronic, severe, traumatic brain injury. Neurosurgery. 2015 Dec 21; [Epub ahead of print]

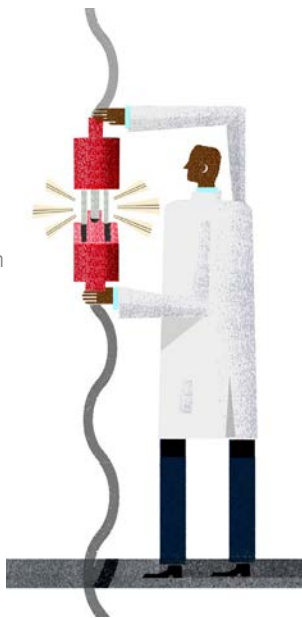
Brain-Computer Interface Restoring Hand Function in a Patient with Quadriplegia

Ian Burkhart, who is paralyzed as the result of an accident, is able to move his hands and fingers again with the help of an implantable device that allows him to use his thoughts to initiate movements. A collaboration with engineers at Battelle, the process utilizes a brain implant in Ian’s motor cortex linked to a wearable arm stimulation sleeve. A computer interface allows the brain signals Ian associates with hand movements to bypass his damaged spinal cord.

DBS for Severe Traumatic Brain Injury

Patients with chronic severe traumatic brain injury can have significant problems with cognition, behavioral and emotional regulation, community and social interactions and self-care. Our phase I feasibility pilot study demonstrated that DBS improved functional outcome, independence in self-care, activities of daily living and behavioral self-regulation and adjustments. Due to these promising results, our team is planning to conduct future studies with randomized sham-controlled trials.

The team is currently enrolling patients in a new multicenter phase I trial that uses HIFU to treat patients with refractory dyskinesia associated with Parkinson’s disease — one of only three sites in the nation conducting this research. In addition, they are also leading efforts to investigate HIFU thalamotomy for patients with partial-onset epilepsy.





SPINE RESEARCH INSTITUTE

New Technologies that Personalize Care

At the Ohio State Spine Research Institute (SRI), innovative technologies are transforming the diagnosis and treatment of spinal conditions. The SRI is an example of the multidisciplinary collaboration between the College of Engineering and Neurological Institute physicians and scientists. The team of engineers and clinicians has developed a wearable diagnostic tool called the Clinical Lumbar Motion Monitor (CLMM) that generates quantitative, replicatable measures of an individual's spine function. Patients perform a variety of prescribed movements wearing the backpack-like CLMM, and researchers analyze their functional data to help clinicians optimize patients' spine health and develop care plans.

SRI Director William Marras, PhD, says the challenge of treating many painful and debilitating conditions, such as low back pain, is that they are so difficult to assess objectively. "The CLMM allows us to see the individual motion signature of a patient with a back disorder as compared to someone who is functioning well. By tracking the way people move, we can see where impairment is occurring and if other factors are influencing it. Plus we can evaluate the changes in a

patient's condition by comparing their individual data over time and make recommendations for treatment depending on how their recovery is progressing."

In addition, using CT and MRI imaging, Dr. Marras and his team are building personalized, three-dimensional spine models that surgeons can use to assess and even test different options for spine procedures. Because the models provide information about load-bearing forces and other factors impacting the various tissues, muscles and bones of a particular patient, the technology is an invaluable tool, says neurosurgeon Ehud Mendel, MD, FACS, clinical director of the Ohio State Spine Research Institute.

"For example, developing a surgical plan for a patient whose spine has degenerated significantly due to trauma, infection or malignancy is very difficult," explains Dr. Mendel. "Using the models allows us to consider various approaches and also assess whether a procedure will result in sufficient spinal repair and stability."

Because the College of Engineering and Wexner Medical Center sit so closely on Ohio State's campus, faculty have the unique opportunity to collaborate and research. Patients and physicians can visit the engineering labs, and engineers can observe physicians and patients in the clinical setting.



“*By tracking the way people move and recording our findings, we can see where impairment is occurring, if other factors are influencing it and how recovery is progressing.*”

William Marras, PhD
Director, Spine Research Institute



COMPREHENSIVE SPINE CENTER

Combining Neurosurgical and Orthopedic Modalities to Serve Patients Better



“Our goal is to help as many patients as possible. In fiscal year 2016, Comprehensive Spine Center saw more than 37,000 patients and performed more than 5,200 procedures.”

Albert Timperman, MD
Director, Comprehensive Spine Center

Albert Timperman, MD, director of the Ohio State Comprehensive Spine Center, believes that the greatest successes for patients result from the treatment team’s shared dedication to service.

Better Options for Patients

This highly personalized approach spans the spectrum of each person’s unique spine care, from simple to complex surgery, to minimally invasive to preventive. Neurosurgeons, orthopedic surgeons and nurse practitioners (NPs) partner with specialists in physical medicine and rehabilitation, neurology, pain management, physical therapy, anesthesiology, radiology and psychology for collaborative care delivery.

“I can walk down the hall and consult with our pain management specialists, arrange for imaging, or get input from a neurologist on a patient’s situation,” says Dr. Timperman.

To address patients’ pain and functional issues, physical medicine and rehabilitation physicians, anesthesiologists and NPs provide more than 475 interventional therapies per month. These therapies include trigger point injections, radiofrequency ablative procedures, epidural steroid injections, facet blocks and treatment of regional pain syndromes, and peripheral nerve and spinal cord stimulation.

Unique Peripheral Nerve Clinic

The Ohio State Peripheral Nerve Clinic helps those who, as a result of injury such as nerve avulsion, stretch or repetitive strain, develop numbness and tingling,

neuropathic pain, weakness or even paralysis. Clinicians evaluate and treat brachial plexus and peripheral nerve injuries as well as neoplasms and compression syndromes in the upper or lower extremities.

A multidisciplinary team brings different approaches and perspectives to the clinic’s innovative care. “Each patient is initially seen by two neurosurgeons, which makes for a more evolved decision-making process,” explains Milind Deogaonkar, MBBS, who co-directs the clinic with fellowship-trained peripheral nerve neurosurgeon Francis Farhadi, MD, PhD.

Clinical Trials Hold Hope for the Future

Current Ohio State Comprehensive Spine Center clinical trials are investigating new treatments for cervical spondylotic myelopathy, spinal cord injury and spinal fusion, and biomechanical testing is examining internal and external stresses on the spine to help predict and prevent injury.

“Research holds the hope that someday people can recover from major neurological deficits, and allows our patients to be participants in the care of the future,” says Dr. Timperman. “We can’t even imagine the possibilities that are on the horizon.”





BRAIN AND SPINE TUMOR CENTER

Pushing the Boundaries of Discovery and Innovation



“*These opportunities for collaboration are vital, providing new options for treatments and also for translating lab discoveries to meaningful clinical care.*”

Vinay Puduvalli, MD
Medical Director, Neurological Service Line

Ohio State Brain and Spine Tumor Center practitioners draw on a wealth of knowledge and expertise for both patient care and research excellence.

“Patients have access to the resources of a major academic medical center as well as a National Cancer Institute-designated Comprehensive Cancer Center, OSUCCC – James — which is neither typical or usual,” says neuro-oncologist Vinay Puduvalli, MD, neurological service line medical director. “These opportunities for collaboration are vital, providing new options for treatments and also for translating lab discoveries to meaningful clinical care.”

Center practitioners include neuro-oncologists, neurosurgeons, radiation oncologists, neuroradiologists, neuropathologists and specialists in neuropsychology, rehabilitation and pharmacy. In addition, the center has an exceptional team of nurse practitioners, nursing staff, social workers, patient access coordinators and schedulers, says Dr. Puduvalli. “We also work closely with a variety of scientists and researchers across Ohio State to provide the expertise each patient needs.”

Moving the Line to Give Patients Time and Hope

Exploring ways to “move the line” on patients’ survival rates through innovative therapies is a cornerstone of research and treatment.

Says J. Bradley Elder, MD, “Right now we may be able to give someone with a particularly aggressive cancer a little more time, from, say, 12 to 15 months. But that’s 25% longer — and eventually that 25% becomes years, as we are making discoveries to find a cure.”

Laboratory Discoveries Transform the Landscape of Care

The Brain and Spine Tumor Center’s researchers are constantly pushing the boundaries of known treatment options to develop the next generation of cutting-edge therapies. One current clinical trial has the goal of generating a vaccine based on patients’ own tumors and immune responses. “The immune system trains itself to remember things it has fought before, so patients’ individual immune cells learn to recognize abnormal proteins and are then able to fight them,” Dr. Elder explains.

Other current collaborative trials and research projects are investigating:

- Injecting the cold virus along with an immune stimulator for treatment of primary brain tumors
- Implanting catheters into the brain to directly infuse chemotherapy around the surgical cavity after tumor removal
- Using heat shock proteins to disable the protections on tumor cells and sensitize them to chemotherapy and radiation

Promise for the Future

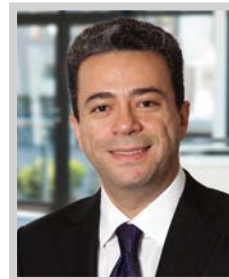
Research provides not only better treatments but more creative ideas to explore, Dr. Elder explains. “Sometimes you learn what works to treat people by discovering what doesn’t work, because that can lead you to conceptualize and explore different options you might not have considered. It’s like a marathon, but every day we move closer to the happy side of the equation.”





COMPREHENSIVE STROKE CENTER

Streamlining Treatment and Extending Our Reach



“Only 7 centers in the country are part of both networks — which certainly speaks to our research strength and allows us to provide for patients far beyond the standard of care.”

Michel Torbey, MD
Medical Director, Neurovascular Stroke Center

Timing is critical in treating strokes, so mobilizing resources immediately is vital. “While patients are having their initial diagnostic imaging, the stroke and surgical teams are consulting to make the best decisions for their care,” says neurosurgeon Ciaran Powers, MD, PhD.

These synergistic collaborations tap the expertise of neurointensivists, neurosurgeons, vascular surgeons, neurologists, neurocritical care physicians, and imaging and rehabilitation specialists. And through care and research partnerships, the team is extending its reach across Ohio and beyond.

Telestroke Improves Outcomes and Quality

As a central provider in the Telestroke network, Ohio State Neurovascular Stroke Center specialists provide around-the-clock critical and ongoing support to physicians and patients at 25 “spoke” hospitals that serve rural areas of Ohio.

When patients come into the spoke hospitals with symptoms, stroke center physicians help evaluate their condition and determine treatment options. “For instance, sometimes an emergency room physician is not as experienced at providing IV TPA for ischemic stroke, and we can guide and advise them through the procedure and follow-up care,” explains Dr. Powers.

Elite and Innovative Research Networks

The Ohio State Neurovascular Stroke Center was selected by the National Institutes of Health to participate in its Neurological Emergencies Treatment Trials network, a

nationwide research effort aimed at improving patient outcomes in the emergent phase of care for severe injuries and illnesses of the brain, spinal cord and nervous system. In addition, the center is part of StrokeNet, an elite network of 25 regional stroke centers conducting clinical trials on stroke prevention, treatment and recovery.

Says neurologist and Medical Director Michel Torbey, MD, “Fewer than 10 centers in the country are part of both networks — which certainly speaks to our research strength and allows us to provide for patients far beyond the standard of care.”

More Time for Treatment

Among the center’s innovative clinical trials is the NIH-sponsored Diffuse 3, which extends the intervention period for treating ischemic strokes from six hours to 16. “This is a very exciting trial because we were seeing many patients come in past the window for treatment, and now have the option to try other therapies,” says Dr. Torbey.

Another clinical trial is investigating intraventricular versus oral nimodipine to improve outcome after subarachnoid hemorrhage. The Neurovascular Stroke Center’s clinical trials cater to patients in all stages of stroke care, from prevention through the acute phase to rehabilitation.

“We’re extremely pleased that about half of our patients choose to participate in one of our trials,” says Dr. Torbey.





CENTER FOR BRAIN AND SPINAL CORD REPAIR

Translational Research and Training Are Catalysts for Change

The Ohio State University Wexner Medical Center was recently awarded a five-year, \$2.2 million grant from the National Institute on Disability, Independent Living, and Rehabilitation Research to build the Ohio Regional Spinal Cord Injury Model System. Ohio State is one of only seven Level I trauma centers nationwide linked with a spinal cord injury rehabilitative program and a governmental-funded Spinal Cord Injury Model System.



The team at Ohio State's Center for Brain and Spinal Cord Repair is taking the bench-to-bedside journey of research to translation in an exciting new direction. "We're approaching understanding and improvement in care for people with spinal cord injuries from a systems-level perspective," says Phillip Popovich, PhD. Dr. Popovich, along with Jan Schwab, MD, PhD, and Dana McTigue, PhD, is advancing knowledge of how malfunction of the immune and digestive systems, among others, impacts a patient's recovery.

Adds Dr. McTigue, who also heads the center's internationally renowned Spinal Cord Injury (SCI) training program, "This is a quality-of-life issue for patients and addresses a range of systemic problems for which we hope to find better solutions."

"True Translation" Projects

Partnerships with specialists in neurosurgery, psychology, physical therapy and acute and critical care, among many others, are helping researchers develop new treatment options to prevent and deal with the consequences of these multisystem breakdowns. Some current investigations involve:

- Determining how neuroimmune interactions and whole-body metabolism changes negatively impact health and recovery of function after SCI

- Assessing how gut function and the gut microbiome changes as a result of autonomic nervous system disruption
- Defining the connections between dysautonomia and conditions such as anxiety, depression, debilitating fatigue and cardiovascular risk factors

"These are true translation efforts with science, training and clinicians closely affiliated," notes Dr. Schwab, who says treatment development is building on decades of SCI research excellence at Ohio State. "Our shared interests are galvanizing — these translation efforts are just the catalyst for what was already there."

SCI Training Foundational and Far-Reaching

More than 200 trainees from 20-plus countries have completed the SCI research training program in the last decade. The program, initially funded by NIH, is now supported by the Craig H. Nielsen Foundation.

As a result of the training program, "I think of our center as an extension of hundreds of different labs all over the world," says Dr. Popovich. "People see us as a resource and seek us out for questions and advice — a connection which leads to ongoing, dynamic collaboration."

Some Recent Publications from Our Team

Kigerl KA, Hall JC, Wang L, Mo X, Yu Z, Popovich PG. Gut dysbiosis impairs recovery after spinal cord injury. *J Exp Med.* 2016 Nov 14;213(12):2603-2620.

Ueno M, Ueno-Nakamura Y, Niehaus J, **Popovich PG,** Yoshida Y. Silencing spinal interneurons inhibits immune suppressive autonomic reflexes caused by spinal cord injury. *Nat Neurosci.* 2016 Jun;19(6):784-7.

Church JS, Kigerl KA, Lerch JK, Popovich PG, McTigue DM. TLR4 deficiency impairs oligodendrocyte formation in the injured spinal cord. *J Neurosci.* 2016 Jun 8;36(23):6352-64.

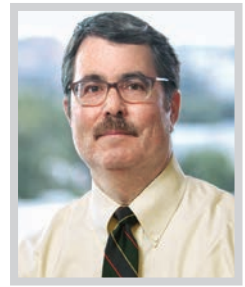
Carpenter RS, Kigerl KA, Marbourg JM, Gaudet AD, Huey D, Niewiesk S, Popovich PG. Traumatic spinal cord injury in mice with human immune systems. *Exp Neurol.* 2015 Sep;271:432-44.

Brommer B, Engel O, Kopp MA, Watzlawick R, Müller S, Prüss H, Chen Y, DeVivo MJ, Finkenstaedt FW, Dirnagl U, Liebscher T, Meisel A, **Schwab JM.** Spinal cord injury-induced immune deficiency syndrome enhances infection susceptibility dependent on lesion level. *Brain.* 2016 Mar;139(Pt 3):692-707.



CENTER FOR COGNITIVE AND MEMORY DISORDERS

Developing Tools to Help Patients Sooner



“We’re the only center in the country accredited for both Geriatric Neurology and Behavioral Neurology and Neuropsychiatry fellowships.”

Douglas Scharre, MD
Director, Center for Cognitive and Memory Disorders

Emphasizing accessible, practical, cost-effective solutions in patient care, as well as conducting research to facilitate those solutions, is a theme of the Ohio State Center for Cognitive and Memory Disorders.

“It’s very satisfying to produce tools that can help people now,” explains center Director Douglas Scharre, MD.

SAGE Test for Early Screening

Dr. Scharre heads the research team that created the Self-Administered Gerocognitive Examination (SAGE), an assessment instrument designed for early screening of individuals with cognitive impairment and possible symptoms of dementia. The test was inspired by the people he and other center specialists observed coming in after the window for the best treatment options had closed.

“We knew we could do better to help people anticipate and potentially receive treatment for the medical and quality-of-life issues that result from a decline in brain function,” Dr. Scharre recalls.

Support for Patients and Caregivers

More than 170 specialists and fellowship-trained practitioners in cognitive disorders, geriatrics, social work, internal medicine, neurology, neurosurgery and imaging collaborate to treat patients — and also to address the ongoing challenges of diseases like Alzheimer’s. “In our monthly neurobehavior case conference, we invite patients and caregivers to share their stories,” says Dr. Scharre. “This helps us learn more about disease progression, how treatments are working and how we can best support patients and families.”

This holistic approach to treatment is also reflected in the center’s unique two-track fellowship program. “We’re the only center in the country accredited for both Geriatric Neurology and Behavioral Neurology and Neuropsychiatry fellowships,” Dr. Scharre explains.

Collaborative Clinical Trials and Research

Ongoing research includes a partnership with Biomedical Engineering that examines the physical characteristics of blood and spinal fluid in people experiencing different levels of cognitive impairment. “This relatively inexpensive but exquisite use of nanotechnology may help us identify biomarkers that can predict disease progression or disease stabilization,” says Dr. Scharre.

Another trial, a collaboration with neurosurgery specialists, is investigating the safety and efficacy of deep brain stimulation as a treatment option for patients with Alzheimer’s disease. Developing treatments for the common but little understood Lewy body dementia is an additional area of focus: the newest Lewy body trial examines the clinical signature of the disease using neuroimaging and sleep characteristics.

“Our research is making patients’ lives better,” says Dr. Scharre, “and I like to think that we continue to be very successful at producing impactful results and solutions.”





INSTITUTE FOR BEHAVIORAL MEDICINE RESEARCH

Stress and High-Fat Meals Combine to Slow Metabolism in Women

“The Institute for Behavioral Medicine Research (IBMR) functions as an incubator to create and disseminate cutting-edge mind-body research that will enhance individual and community health.” Janice Kiecolt-Glaser, PhD



A new Ohio State study, led by Janice Kiecolt-Glaser, PhD, suggests that women experiencing one or more stressful events the day before eating a single high-fat meal can slow the body’s metabolism, potentially contributing to weight gain.

The research was conducted at the Institute for Behavioral Medicine Research (IBMR), the cornerstone of a broad research program at The Ohio State University in the field of psychoneuroimmunology (PNI) – the study of how the brain interacts with the body’s immune system. This field has evolved from a novel area of curiosity to an important scientific field, one that has meaningful implications for public health and great promise for enhancing medical treatments.

Before giving study participants a meal consisting of 930 calories and 60 grams of fat, researchers asked about the previous day’s stressors. The scientists then measured each participant’s metabolic rate — how long it took the women to burn calories and fat — and also recorded levels of blood sugar, triglycerides, insulin and the stress hormone cortisol. On average, the women in the study who reported one or more stressors during the previous 24 hours burned 104 fewer calories in the seven hours after eating the high-fat meal than the non-stressed women.

In addition, the stressed women had higher levels of insulin, which contributes to the storage of fat and reduces fat oxidation — the conversion of large fat

molecules into smaller molecules that can be used as fuel. Fat that is not burned is simply stored.

“This means that, over time, stressors could lead to weight gain,” says Dr. Kiecolt-Glaser. “We know from other data that we’re more likely to eat the wrong foods when we’re stressed, and our data say that when we eat the wrong foods, weight gain becomes more likely because we are burning fewer calories.”

IBMR researchers represent expertise in the fields of immunology, virology, psychiatry, psychology, endocrinology, molecular biology, behavior, oncology and the neurosciences. Recent mind-body research at the institute has shown:

- Chronic stress can weaken the immune status of caregivers, thereby increasing their risk for certain diseases.
- High levels of psychological stress can impede wound healing, impairing recovery from minor procedures to major surgery.
- High levels of stress may interfere with the efficacy of bacterial and viral vaccines.
- Even among healthy, “happy” individuals, minor psychological stress can negatively impact health.





AIR FORCE RESEARCH LABORATORY

Research Partnerships



“It is amazing how much we have accomplished and how many research activities we are collaborating on together.”

Scott Galster, PhD
Chief of the Applied Neuroscience Branch in the 711 Human Performance Wing at Wright-Patterson Air Force Base.

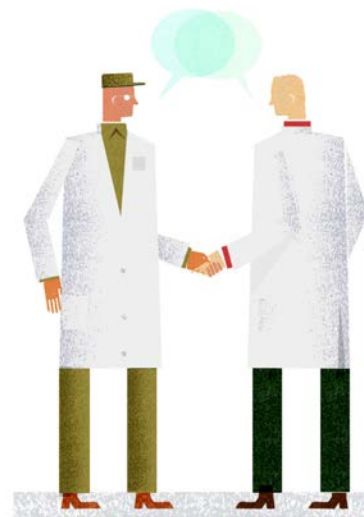
The Neurological Institute and the Air Force Research Laboratory (AFRL) recently completed the second of a four year Cooperative Research and Development Agreement. This agreement has produced a number of advances that will increase physical and mental performance and improve the lives of patients, military personnel and athletes.

“It is amazing how much we have accomplished and how many research activities we are collaborating on together,” says Scott Galster, PhD, Chief of the Applied Neuroscience Branch in the 711 Human Performance Wing at Wright-Patterson Air Force Base.

These collaborative projects utilize a continuum of functionality created by Dr. Galster and Dr. Ali Rezai, Director of the Neurological Institute, which examines changes in human performance, recovery and readiness. The team has increased the depth and scope of its collaboration by jointly designing and executing experiments, participating in personnel exchanges and even sharing specialized equipment to reduce the total cost of conducting experiments.

The Sense-Assess-Augment framework is used to structure and guide this collaborative work. The framework is similar to the diagnostic approach used in the medical field: testing, providing a diagnosis and then a treatment. In the sense component, the team is tracking and employing robust commercial and proprietary sensors to get comprehensive measures related to brain body physiological markers, biomarkers, and cognitive acuity. In the assess element, they systematically combine all of this data and provide analytic approaches that result in meaningful, personalized, and actionable information about the state of recovery, readiness, or performance. Finally, they are working to generate personalized augmentations based on the assessment to help optimize performance for patients, military personnel and athletes.

“I often think back to our kick-off meeting where we outlined our ambitious goals and the comment Senator John Glenn made when he honored us by attending,” recalls Dr. Galster. “Senator Glenn said, ‘The final frontier for exploration and discovery is between our ears.’”





THE NEUROLOGICAL INSTITUTE'S INAUGURAL

Global Brain Health and Performance Summit 2016

The Inaugural Brain Health and Performance Summit featured plenary sessions on topics ranging from avatar science and targeted brain stimulation to device development and the latest findings on cognitive health and aging. Highlights included an opening panel exploring brain body science and athletic performance and a panel discussion on technological breakthroughs changing the lives of those with debilitating neurological conditions. The keynote address by Arianna Huffington presented scientific findings that sleep rejuvenates our bodies and brains and is a performance enhancer in all areas of our lives.



Unlocking the potential of the human brain

The Stanley D. and Joan H. Ross Center for Brain Health and Performance was created to help unlock the potential of the human brain and redefine brain health. The Center conducts life-changing brain research and disseminates findings to both healthcare professionals and the general public.

We are exploring ways to measure, analyze and improve brain function. New discoveries will allow us to help people optimize their brain performance by managing factors that deplete it, as well as more rapidly replenishing expended reserves.



Joan H. and Stanley D. Ross



Some highlights of our center's activities include:

- Receiving a \$2.5 million gift from the Harry T. Mangurian Jr. Foundation to establish the Human Performance Innovation Initiative, which will build on existing research collaborations with the Ohio State Neurological Institute, Ohio State Athletics and the United States Air Force Research Laboratory
- Receiving a 3-year \$1 million grant from the Rudi Schulte Research Institute of Santa Barbara, California for four pilot studies exploring the dynamic status of neurocapacity
- Entering into a partnership with the Huffington Post to curate and disseminate content on Brain Health and Performance for a public audience
- Hosting the inaugural Brain Health and Performance Summit in partnership with the Neurological Institute and Department of Athletics. The event was attended by more than 200 researchers, practitioners, entrepreneurs and specialists, to explore the latest scientific discoveries and most innovative technological advances to optimize brain health, recovery, function and healing

Being Modern: The Contemporary Neurological Institute



The neurological sciences, both clinical and laboratory, represent the epitome of modern medicine. Neurosurgery in particular represents one of medicine's most formidable achievements. During the past century the specialty has undergone a striking metamorphosis, both in techniques and in its place within the social mosaic of modernity.

Neurosurgery evolved from individuals to surgical divisions and then departments during the twentieth century. However, it has become clear that further progress and optimization of care delivery in modern neurosurgery requires a unified and sophisticated multidisciplinary approach. Specialization and subspecialization is the hallmark of cutting-edge medicine and it is never more important than in the realm of neurological diseases, their treatment and sophisticated study.

Thus we see the emergence of the bona fide "brick-and-mortar" Neurological Institute that offers an amalgam of relevant specialties under one roof to facilitate communication, exchange of ideas, canalization of progress and optimization of patient care. These institutes are composed of neurological surgery, neurology, psychiatry, rehabilitation medicine, laboratory neuroscience and their support services, operating in tandem under one roof or on compact campuses.

Such is the promise of optimization for health care and the offering of the most fertile environment for contribution to science and progress.

The evaluation and management of the complexities of neurological diseases demands nothing less.

The Neurological Institute at the Ohio State University through its leadership, components, and clarity of direction is a unique example of bringing this concept to practical reality.

Michael L. J. Apuzzo, MD
Distinguished Adjunct Professor of Neurosurgery Yale University
Senior Consultant Neurological Institute The Ohio State University

April 27 - 29
Hilton
Columbus
Downtown



Deepak Chopra, MD
Pioneer and Advocate
in Integrative Medicine



Dan Buettner
National Geographic Fellow
Author of "The Blue Zones"



Nathan Price, PhD
Institute for Systems
Biology (ISB)
Seattle 100K Wellness
Project

Second Annual Global Brain Health and Performance Summit *will explore:*

- The identification, validation and application of biomarkers toward the enhancement of brain health and performance
- Lifestyle practices, such as sleep, nutrition, exercise and mindfulness, and how they affect results on the playing field, battlefield and in everyday life
- The impact of inflammation on cognitive and physical function
- Technological advances in human performance sensors and analytics for the prediction and measurement of functional disease outcomes

Keynote Speakers

Keynote, plenary and breakout sessions will feature top scientists from academia, industry and government to discuss innovations in research and development designed to enhance brain health and human performance.

Visit go.osu.edu/brainhealth for updates.